

NOTES ON THE BIOLOGY OF
ZEGRIS EUPHEME (PIERIDAE)

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By comparison with the much researched Pierini, the ecology and behavior of Euchloini are rather poorly known. Only for the Palaearctic *Anthocharis cardamines* L. have detailed studies been made (Williams, 1915; Wiklund & Ahrberg, 1978). In this note I record some observations made in Morocco during 1978 on another euchloinid, *Zegris eupheme* Lederer, which are of interest for their similarities and contrasts with *A. cardamines* and with Pierini.

Z. eupheme is a large handsome insect, of disjunct distribution in the Palaearctic, being found in southern Spain and Morocco (subspecies *meridionalis*), and southern U.S.S.R., Asia Minor and the Near East (subspecies *eupheme*). It is unusual among the Pierinae in being particularly associated with a single crucifer species, *Isatis tinctoria* L., although it may use other Cruciferae as larval host plants (Powell, 1932). In the Middle Atlas Mountains of Morocco, the butterfly flies during late April and May and may often be seen in areas where the foodplants are growing. At this time of year the growth of vegetation is rich and verdant in valley bottoms; spring is the time of greatest floral and faunal abundance (thereafter the high summer temperatures give a very desiccated-looking landscape). *I. tinctoria*, a large, yellow-flowered crucifer about 1 m in height, grows in peripheral open areas around valleys, including roadsides and stony banks, where vegetation is otherwise short. At Ifrane, in the Middle Atlas, *Z. eupheme* has been associated with *I. tinctoria* since at least 1965, when the late Baron de Worms (1965) recorded flourishing populations of butterfly and crucifer in a hollow next to the Ballima Hotel. On subsequent visits he confirmed the continuing success of both populations, which were both still abundant in 1978. Most of the observations recorded here were made in this small area (about 100 m square); however, *I. tinctoria* occurred in sporadic small groups elsewhere, and *Z. eupheme* was very wide-ranging and could be found in almost any habitat in the area (ranging from rocky slopes to cedar forest).

As to be expected from its size, *Z. eupheme* is a very fast flier, making it impossible to net by pursuit. Like the satyrid *Eumenis semele* (L.), it often evades capture by dropping below the sweep of the net. The only successful method of capture is to station oneself in areas where *Z. eupheme* is flying and try 'head on' shots. The males

appear to 'patrol' (*sensu* Scott, 1974) areas in search of females, and during such flight they investigate any flying insects of the approximate size and color of *Z. eupheme*. Thus, males were seen to chase, vigorously and persistently, individuals of the white pierids, *Pieris brassicae* L. and *Artogeia rapae* (L.), and the yellowish pierids, *Gonepteryx rhamni* L. (both the primrose colored male, and the paler female) and *Colias crocea* Gffy. All such interactions were initiated by *Z. eupheme*, although other pierids are equally investigative in other situations. Several interactions were seen between males of *Z. eupheme*, but only one encounter was observed between sexes, which happened to produce a successful courtship and copulation. On being contacted the female flew about 10 m, with the male spiralling vigorously around her. She then landed, with the male continuing in the air and after a few seconds took off again. Once more the male appeared to force her to the ground but did not settle himself, fluttering around her head. This process was repeated several times, and on each occasion the pair moved a few meters. Eventually, the male settled down in a head to head position and rapidly moved around and initiated copulation with the now quiescent female. At this point the animals were collected; dissection of the female revealed no spermatophores, confirming that she was unmated. Seven other females each contained a single spermatophore, perhaps indicating that *Z. eupheme* leans toward monogamy as does *A. cardamines* (Courtney, 1980). At no time did females adopt the 'mate-refusal' posture (raising the abdomen vertically, while spreading the wings), a typical reaction of other Pierinae females.

The eggs of *Z. eupheme*, like those of most Eucloini, are placed upon the inflorescences of the crucifer host. When laid the egg is white, but it soon develops a red color, as in other Holarctic Eucloini (e.g. Williams, 1915). By careful examination of the flowerheads of *I. tinctoria*, it is readily possible to find the eggs. During the inclement weather of 28 and 29 April 1978 (snow occurred on May 1), the position of every *Z. eupheme* egg on *I. tinctoria* at the Ballima Hotel site was mapped. It was soon apparent that only certain *I. tinctoria* were chosen as oviposition sites. Eggs were concentrated upon unopened buds, and open flowers were never chosen (Table 1). Similar behavior in *A. cardamines* has been hypothesized to be adaptive, leading to larval feeding only on young buds and fruit, which represent optimal food (Wiklund & Åhrberg, 1978). Additionally, eggs were nonrandomly distributed among foodplants, with plants on the edge of the clump receiving many more eggs than those in the center. However, since edge plants are automatically those at low density, it is impossible to decide whether female *Z. eupheme* prefer to lay eggs

TABLE 1. *Z. eupheme* eggs upon *I. tinctoria* plants of different floral ages.

Plants with —	N	Number of eggs
10% flower buds open	377	85
10-90% flower buds open	233	19
Flowers fully open	121	0
	731	104

$\chi^2 = 41.6$, $P < 0.001$ at 2 d.f.

on plants at low density or prefer edge plants or both. Fig. 1 presents the observed deposition of eggs as a density plot. Similar patterns of egg deposition are known for *A. cardamines* (Wiklund & Ahrberg,

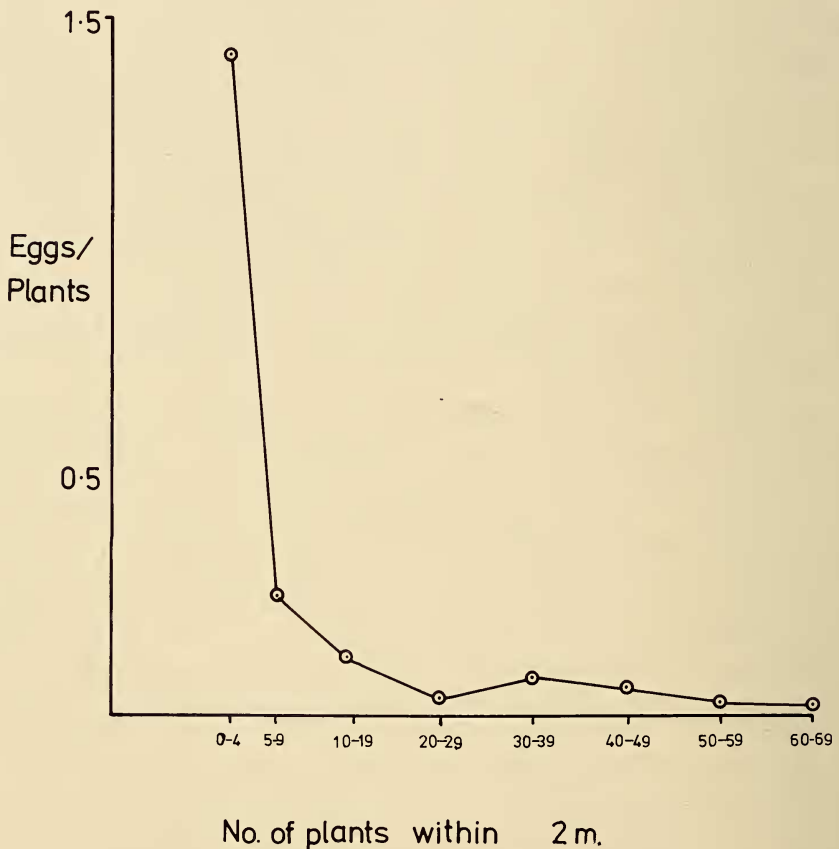


FIG. 1. The effect of *I. tinctoria* density (expressed as the number of other individuals within 2 m) upon the *Z. eupheme* eggload (eggs/plants). A total of 104 eggs on 731 plants were found.

1978) and for the pierids *Artogeia rapae* (e.g. Kobayashi, 1965), *A. napi* (in prep.), *Pontia protodice* and *P. occidentalis* (Shapiro, 1975). Various hypotheses have been suggested for the cause of such 'edge' effects, including choice by females of areas where parasite attacks are rare (Shapiro, 1975) and the incidental effects of female movement patterns and searching behavior (Jones, 1977). In such a large, mobile butterfly as *Z. eupheme*, Jones's hypothesis predicts an extremely pronounced edge-effect, as appears to be the case at Ifrane (a fuller discussion of edge-effects in Pierinae, particularly *A. cardamines*, is in preparation). The age of *I. tinctoria* inflorescences was not related to plant density.

Larvae of *Z. eupheme* were not studied. Beautifully camouflaged crab-spiders, common on the flowerheads of *I. tinctoria*, were potential predators. Powell (1932) records a very high rate of parasitism by braconids (*Apanteles* spp.).

Z. eupheme adults were only seen to feed from *I. tinctoria* blooms, despite a profusion of other nectar sources available. The adults were also frequently found roosting upon the host plant, at which times the yellow-green mottling of the hind-wing underside provided admirable camouflage, blending with the yellow inflorescences. It may be that restriction of larval feeding to a single plant species (or predominantly so) has allowed similar specializations (to predictable resources) in adult behavior.

ACKNOWLEDGMENTS

Although the Ballima Hotel site is openly accessible, I soon became aware that it is, in fact, a restricted area, belonging to the Moroccan Army. To the senior officers, who accepted my explanations as to cryptic maps (of flowers and butterfly eggs) and released both me and my data, I am extremely grateful. This work was carried out during the tenure of an S.R.C. Research Studentship.

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